

Amendments to the Specification:

Please amend the paragraph at page 88, line 27 to page 89, line 6 as follows:

FIGS. 24A to 24D illustrate the structures of optical displacement sensors to be used as an optical encoder according to the sixteenth, seventeenth and eighteenth embodiments of this invention. FIGS. ~~21A~~ 24A to ~~21C~~ 24C are plan views respectively showing the sixteenth to eighteenth embodiments as viewed from the -z direction.

Please delete the paragraphs at page 98, lines 13-21.

Please amend the paragraph at page 98, line 23 to page 99, line 2, as follows:

According to one aspect of the present invention ~~of claim 6, making~~ the beam size on the light emitting surface of the surface emitting laser is 3 μ m or larger (which was difficult to achieve using the edge emitting type semiconductor laser that had been used in conventional encoders) ~~can~~ so as to provide a beam with a small spread angle of less than 20°.

Please delete the paragraphs at page 99, line 18 to page 100, line 21.

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Amendment under 37 CFR 1.312

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Please amend the paragraph at page 100, lines 22-25 as follows:

A According to another aspect of the present invention,
a plurality of light ~~beam~~ beams are irradiated on different
areas on the scale, thereby forming a plurality of
diffraction interference patterns on different areas on the
light receiving surface.

Please delete the paragraphs at page 101, lines 10-21.

Please amend the paragraph at page 101, lines 22-27 as follows:

~~A~~ According to another aspect of the present invention,
a plurality of light ~~beam~~ beams are irradiated on different
areas on the scale, thereby forming a plurality of
diffraction interference patterns on different areas on the
light receiving surface, thus ensuring reliable isolation of
signals from the individual light intensity detecting means.

Please amend the paragraph at page 102, lines 10-18 as follows:

~~According to the embodiment relating to the invention~~
~~of claim 17~~ When there are a plurality of different
diffraction interference patterns, by way of contrast, the
difference in phase among a plurality of diffraction
interference patterns detected by the individual detecting
means can be set based merely on the positional relationship
among the diffraction interference patterns on the scale.
This eliminates the need for changing the arrangement of the
light receiving area constituting each detecting means.

Please delete the paragraphs at page 102, line 19 to
page 103, line 1.

Please amend the paragraph at page 103, lines 2-12 as
follows:

According to ~~the embodiment relating to~~ another aspect
of the present invention of claim 19 the scale surface and
the light receiving surface of the photosensor are tilted to
the principal axis of the light beam which is emitted from
the coherent (laser) light source. It is thus possible to
prevent the light beam from the laser light source and
reflected at the scale or the surface of the photosensor
from returning to the light source, thereby suppressing the
superimposition of noise caused by the returning laser light
on the output signal of the sensor.

Please amend the paragraph at page 103, lines 13-15 as follows:

This embodiment ~~relating to the invention of note 16~~ can therefore ensure scale displacement sensing at higher precision and higher reliability.

Please delete the paragraphs at page 103, lines 16-20

Please amend the paragraph at page 103, line 21 to page 104, line 1 as follows:

According to ~~the embodiment relating to~~ another aspect of the present invention of claim 20, the pitch direction of the diffraction grating is arranged in parallel to the light receiving surface of the photosensor, the spatial period of the diffraction interference pattern on the light receiving surface becomes constant, which simplifies the pattern design and layout of the light receiving areas on the photosensor.

Please amend the paragraph at page 104, lines 15-25 as follows:

~~Arranging~~ By arranging the principal axis of the light beam perpendicular to the pitch direction of the diffraction grating, ~~as in the embodiment relating to the invention of claim 20~~ however, ~~causes~~ the diffraction interference pattern on the light receiving surface ~~to be~~ is generated symmetrically to the principal axis of the light beam. Even if the distance between the scale and the light source changes, therefore, the diffraction interference pattern on the light receiving surface does not move in the pitch direction on the principal axis of the light beam.

Please delete the paragraphs at page 105, lines 12-20.

Please delete the heading at page 105, line 25.

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Please amend the paragraph at page 105, line 26 to page 106,
line 6 as follows:

According to ~~the embodiment relating to~~ another aspect
of the present invention of claim 22 described latter, the
light source and photosensor can be designed compact and
integrated, so that the sensor head can be made smaller as
compared with the structure which has the scale sandwiched
between the light source and photosensor (hereinafter
referred to as a transmission type structure).

Please delete the paragraphs at page 107, lines 4-7.

Please amend the paragraph at page 107, lines 8-15 as follows:

According to ~~the embodiment relating to~~ another aspect ~~of the present invention of claim 23,~~ the pitch direction of the diffraction grating is arranged in parallel to the light receiving surface of the photosensor, so that the spatial period of the diffraction interference pattern on the light receiving surface ~~becomes~~ is constant, which simplifies the pattern design and layout of the light receiving areas on the photosensor.

Please amend the paragraph at page 108, lines 2-13 as follows:

If the pitch direction of the diffraction grating is made perpendicular to the principal axis of the light beam emitted from the aforementioned coherent light source ~~as defined in the invention of note 20,~~ however, the diffraction interference pattern is not shifted on the light receiving surface in the pitch direction in the vicinity of the principal axis even when the distance between the scale and light source changes for the same reason given in the case of the eighth embodiment. This makes it possible to accurately detect the displacement of the scale in the pitch direction of the diffraction grating.

Please amend the paragraph at page 108, lines 18-22 as follows:

Even if the distance between the scale and light source is changed, this reflection type structure ~~, like the invention of note 19,~~ has an advantage that a change in the pitch of the diffraction interference pattern is small.

Please delete the paragraphs at page 108, line 23 to
page 109, line 10.

Please amend the paragraph at page 109, lines 11-18 as
follows:

According to ~~the embodiment relating to~~ another aspect
of the present invention of note 21, as $\phi = 0$, the light
beam may be irradiated to be perpendicular to the surface of
the scale. In this case, it should be noted that return
light noise is generated by the light that returns to the
light source from the scale or the light receiving surface
when z_1 is small. In the usage where such noise generation
is negligible, however, this embodiment has ~~an advantage~~
such advantages that ~~the structure becomes simpler even if~~
the distance between the scale and light source is changed,
a change in the pitch of the diffraction interference
pattern is smaller, and the positional deviation of the peak
of the diffraction interference pattern is smaller, as
compared with the transmission type structure used in the
prior art.

Please delete the paragraphs at page 109, line 26 to
page 110, line 3.

Please amend the paragraph at page 110, lines 4-10 as
follows:

According to ~~the embodiment relating to the~~ present
invention ~~of claim 25~~, the use of the surface emitting laser
light source can make the spreading of the light beam
smaller and can provide an output signal with an excellent
S/N ratio even if the arrangement of the light source, the
scale and the light receiving element is shifted from the
optimal one.

Please delete the paragraphs at page 110 line 11 to page
111, line 2.

Please amend the paragraph at page 111, lines 3-14 as follows:

~~The~~ A beam-splitting optical element ~~is~~ may be disposed in such a way as to include the principal axis of the light beam immediately after it has been emitted from the coherent light source and to split the principal axis of the light beam into a plurality of directions only in the plane perpendicular to the pitch direction of the first scale pattern. Even if the spatial gap between the scale and the light source is changed, therefore, the diffraction interference pattern on the light receiving surface is not shifted to the pitch direction of the scale because of the principle that has been explained earlier with reference to FIG. 17A.

Please delete the paragraphs at page 111, line 23 to page 112, line 4.

Please amend the paragraph at page 112, lines 5-8 as follows:

The second light beam that has been split by the beam-splitting optical element is irradiated on the second scale pattern, ~~having~~ which may have a uniform reflectance, transmissivity or diffraction efficiency.

Please delete the paragraphs at page 112, lines 20-23.

Please amend the paragraph at page 112, lines 24-27 as follows:

~~The embodiment also covers the structure where~~
According to the present invention the number of the tracks of the scale pattern ~~is~~ may be increased to increase the number of associated, split light sources and the number of associated photosensors.

Please delete the paragraphs at page 113, lines 1-4.

Please amend the paragraph at page 113, lines 5-11 as follows:

The ~~second light beam split by the beam splitting optical element is irradiated on the~~ second scale pattern of ~~the~~ may alternatively have a predetermined period p_2 different from that of the first scale pattern, thereby generating a diffraction interference pattern having a spatial period $p_2 = p_1(z_{11}+z_{21})/z_{11}$ on the light receiving surface on the second photosensor.

Please delete the paragraphs at page 113, line 25 to page 114, line 5.

Please amend the paragraph at page 114, lines 6-10 as follows:

The ~~second light beam that has been split by the beam-splitting optical element is irradiated on the second~~ scale pattern ~~having~~ may be a single scale pattern or a plurality of scale patterns formed at a predetermined reference position.

Please delete the paragraphs at page 114, lines 20-27.

Please amend the paragraph at page 115, lines 1-13 as follows:

~~All~~ In the embodiments shown in FIG. 20B and FIG. 24D,
all of the beam-splitting optical elements are arranged in such a way as to include the principal axis of the light beam immediately after it has been emitted from the coherent light source and to split the principal axis of the light beam into a plurality of directions only in the plane perpendicular to the pitch direction of the first scale pattern. Even if the spatial gap between the scale and the light source is changed, therefore, the diffraction interference pattern on the light receiving surface is not shifted to the pitch direction of the scale because of the principle that has been explained earlier with reference to FIG. 17A.

Please delete the paragraphs at page 115, line 14 to page 116, line 2.

Please amend the paragraph at page 116, lines 3-9 as follows:

The second light beam that has been split by the beam-splitting optical element ~~is~~ and irradiated on the second scale pattern having a uniform reflectance, transmissivity or diffraction efficiency, ~~and is~~ may then be irradiated on ~~the~~ a third beam-splitting optical element where its principal axis is deflected again so that the light beam is led to the second photosensor.

Please delete the heading at page 116, line 22.

Please amend the paragraph at page 116, lines 23 and 24 as follows:

This aspect of the present invention corresponds to the seventeenth embodiment of this invention.

Please delete the paragraph at page 117, lines 2-5.

Please amend the paragraph at page 117, lines 6-13 as follows:

~~The~~ In the embodiments shown in FIGS. 22A-22C and FIG. 24B, the second light beam split by the beam-splitting optical element is irradiated on the second scale pattern of the predetermined period p_{12} different from that of the first scale pattern, and is then bended by the first optical beam-bending optical element, thereby generating a diffraction interference pattern having a spatial period $p_2 = p_{12}(z_{11}+z_{21})/z_{11}$ on the light receiving surface on the second photosensor.

Please delete the paragraphs at page 117, line 14 to
page 119, line 1.

Please amend the paragraph at page 119, lines 2-6 as
follows:

~~The~~ According to another aspect of the present
invention, the first light beam emitted from the coherent
light source is irradiated on the first scale pattern, thus
forming a diffraction interference pattern having a spatial
period $p_2 = p_{11}(z_{11}+z_{21})/z_{11}$ on the light receiving surface
of the first photosensor.

Please amend the paragraph at page 119, lines 7-15 as follows:

~~As in the case of the fourth aspect, when~~ When the scale is displaced by p_{11} in the pitch direction of the diffraction grating, the diffraction interference pattern is shifted by $x_2 = p_{11}(z_{11}+z_{21})/z_{11}$ on the light receiving surface in the same direction. Therefore, the first photosensor provides an output signal which changes with a periodic intensity every time the scale is displaced by p_{11} in the pitch direction of the diffraction grating.

Please amend the paragraph at page 119, line 21 to page 120,
line 3 as follows:

By adequately setting the first and second scale patterns, it is possible to achieve the function of monitoring the intensity of the optical output of the coherent light source by detecting the intensity of the light that has been reflected or has passed through the scale having a constant reflectance or transmissivity, the absolute position detecting function by a vernier encoder, the function of detecting the origin based on the reference point pattern, and the like ~~, as per the invention of claims 31 to 33.~~